

An Interview with  
ANDREW MOLNAR

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Conducted by William Aspray

on

25 September 1991

Washington, D.C.

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Andrew Molnar Interview  
25 September 1991

Abstract

Molnar begins with a brief review of his education and career prior to joining the National Science Foundation's Office of Computing Activities (OCA) in 1970. The interview focuses on Molnar's work at OCA and includes discussion of interaction between program officers, computer networks, and computer assisted instruction. Molnar describes the contributions of Pat Suppes, Donald Bitzer, and the MITRE Corporation in computer assisted instruction.

ANDREW MOLNAR INTERVIEW

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INTERVIEWER: William Aspray

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ASPRAY: Let me begin by getting some personal information from you about your background before you came to the Foundation. Tell me about your education.

MOLNAR: I got a Bachelor's and Master's and Ph.D. from the University of Maryland in 1952, '55, and '59, and I took out a year to go to a design engineer program at Pratt & Whitney Aircraft. In 1956, I did two years of engineering in one year it was a design engineers program.

ASPRAY: The degrees at Maryland were in what area?

MOLNAR: In psychology.

ASPRAY: What was your career path then?

MOLNAR: That's a little bit complicated. I had worked for a group called Psychological Research Associates, and we did military research for training systems. I directed a project on the interviewing of Hungarian refugees after the Hungarian Revolution. I was a member of the design team on anti-submarine warfare tactics. I did human factors: the design for training anti-submarine warfare operators. I did a project on combat effectiveness of small unit infantry rifle squads as they were going to Korea, and I worked as a design engineer on the J-75 turbo-jetted Pratt & Whitney aircraft. I taught graduate courses as a graduate assistant at Maryland during this time, and worked at Psychological Research Associates.

From there I went to the Carnegie Corporation, and was the Director of Research and Training. We were a group that designed simulators for petrochemical industries. This was 1958-59. We did human factor studies for helicopters and

anti-submarine warfare aircraft. We built simulators and procedure trainers. We conducted studies on wide-angle visual presentation for aircraft landing simulators. Basically, it was a small company designed to build training and simulation materials for business, industry and the military.

From there I went to System Development Corporation, and was a human factor scientist, and was responsible for running an evaluation facility for decision making for Strategic Air Command. We built the facility and ran experimental tests of the Strategic Air Command decision-making processes. It was a simulation.

Then I went to American University and, for five years, I was there a Professor of Research and Research Scientist in the Center for Research in Social Systems. We did research on underground insurgent revolutionary warfare and wrote several books on the topic. From terrorism to underground activities and counter-insurgency to a whole range of studies. Then in '66 I went to the then Office of Education. To backtrack one minute, at System Development, we worked with, of course, the first use of computers, which was the FSQ-7, which was a whole building of vacuum tubes, and that could hardly do much of what a desktop can do today, and so, therefore, we prepared training exercises for the military using that system, and we also used the computing for the Strategic Air Command. Then, at the then Office of Education, I was the Acting Director for Higher Education Research, and was responsible for instructional materials and development. I was also on the Presidential Transition Team. I was the Executive Secretary for the New Educational Media. At that time, I didn't have people that knew much about technologies of any kind, so I was the Executive Secretary for the group that made the award for Sesame Street, the first activity, into Children's Television Workshop. We had awards to do out of the NDEA Act and the Elementary-Secondary Act we supported computer activities. By default, since I was the only one that had worked with technologies, I was responsible for all of the projects in those areas, and supervised them.

ASPRAY: Could you say a few words about what some of those programs were?

MOLNAR: Oh boy, good question. At that time, we were primarily supporting instructional uses drill and practice, for example, Pat Suppes' project. We supported Suppes in setting up his network at that time. He was doing projects

with Kentucky and Mississippi out of Stanford. And also, Dick Atkinson was another one of our grantees. One of my first tasks was to take a proposal from EDUCOM, which had been given a study grant, and EDUCOM had in fact, I have the book here someplace proposed a multi-million dollar project at that time to get computing into universities. Herb Grosch at the National Bureau of Standards was on the committee. Let's see, a couple of others. I was the Chairman. We were charged with making inter-agency response to EDUCOM. And what we did is we gave them a small award to start a network project. Let me see, what else were we doing at that time? There were no records of what was going on in technology, and so I was put upon to survey all of the offices to find out what they were supporting. Some were providing facilities; some were providing equipment; most were providing training in programming and computing. And so, it was my responsibility to try and put these things together into one report make a report to the Commissioner who was, at that time, Harold Howe and Secretary John Gardner. John Gardner was very interested in technologies. So was Howe. At that time, it took about a year for us to get anything printed by the Government Accounting Office, so we Xeroxed it and gave it to people on the proviso that they would Xerox three copies and return them to us. I think we distributed somewhere around five or ten thousand copies that way. The early stages of computing were really chaotic, and the most important thing is we were concerned with trying to show that there were some possible uses of computing immediately, and so Pat Suppes, at that time, was proposing to not only do drill and practice in mathematics because we felt that was possible I remember the field was saying that that may be possible, but you couldn't count on such things as audio or graphics. These were just beyond the reach of the computing facilities, and so therefore Suppes set up a network to provide aid for inner-city kids in mathematics, and Atkinson was doing reading at that time. I wish I had prepared a little bit, because we have a lot of historical documents here that I could give you some more detail if we had some time.

ASPRAY: I'd very much like to get what you do have available. At least a chance to look at it.

MOLNAR: Okay. What else?

ASPRAY: So, you were at the Office of Education at this time. Then what happened?

MOLNAR: I was there for four years. I guess that the most significant thing at that time was the Rosser report by the National Academy on digital needs [?] and computer needs in universities and colleges. It made a strong case for universities having access to computers for research, but did not say anything about education. And, in response to that, the Pierce Commission, which was a presidential science advisory committee, was organized in '67. Pierce from Bell Labs was the Chairman, and they held hearings, and what we were trying to do was to recommend new and different things to do in the areas of computing, especially educational computing. And I think that was at least the trigger for the involvement of the National Science Foundation and the Department of Education. I guess the significant thing for the Foundation was the Lyndon Johnson speech on February 28, where he directed the National Science Foundation to work with the U.S. Office of Education in establishing experimental programs and developing the potential of computers in education. NSF responded to it by creating the Office of Computing Activities, which I joined after that.

ASPRAY: So, when was it that you joined OCA?

MOLNAR: 1970. And at that time, we were an adjunct we were an office that was not in any of the direct programs reporting directly to the Director. And eventually, that requirement was put into the NSF operating document that we would be responsible at the Foundation for computing for research *and* education, and that gave us the impetus to support educational activities. In the Office of Computing Activities, we had three functions: the computer giving large computers systems to universities

ASPRAY: Facilities Program.

MOLNAR: Facilities Program that John Offenkamp [?] ran. And then we had the Computer Science Program which Kent Curtis ran, and Arthur Melmed ran the educational component. So, we had three components. John . . . came in after Glenn Ingram [?]. Glenn Ingram was I guess it goes back before Glenn was interim when I came on.

ASPRAY: After Rose left?

MOLNAR: After Rose left, right. And then John came on. John was really outstanding. He had been involved at Illinois in the ILLIAC. And the most interesting thing about it was that he was an ex-New York policeman, and he could stare people down or coerce them into talking about things that they never meant to talk about a very wise and smart person.

ASPRAY: You said that Melmed was responsible for *running* the program in education. What was your role?

MOLNAR: I was one of the program officers.

ASPRAY: And how many were there? *Just* in education is fine.

MOLNAR: That's hard to say. Initially, John Lehmann started the training programs, and then John moved over to the computer science programs and I took John Lehmann's place. So there was Arthur, and myself, and then later, Eric McWilliams came on. The main core of the people in the education program came on when we transferred [H.] Guy[ford] Stever came on board. Stever was President of Carnegie Mellon, and we made the mistake of giving him a large computer, and when he came on we thought, "Well, we really have it made now. Somebody that understands computing," but his first action was to do away with the equipment program, Offenkamp's program. Because the computer gave them so much trouble they sold it, and they wanted to come here and make sure they never made that mistake again, of giving people equipment they couldn't use. And so one of the movements was to take the education component and move it over to the Education Directorate, because they were having trouble and they felt this group could strengthen it because of the things that were going on. It was a very, very dynamic time well, 1968 to about '71-'72 when we were in the Office of Computing Activities, because we could do computing. We had, really, a wide array of goals and objectives, and it was a very dynamic time and period. Once we got into the Directorate for Education, things changed. We still had we were then called the Technological Innovations in Education Group and we had Larry Oliver. Larry was responsible for helping set up the 25 or so regional networks that we supported. Eric McWilliams came on, and Eric was responsible primarily for systems. And Dorothy

Gerringer [?] came on. She was out of Case Western Reserve. She was an information scientist. Eric had a Masters degree and was working I think he was running the Cornell computer at that time, and then came to join us. And then myself. So, basically, the main group the main core of the group was Arthur Melmed, Eric McWilliams, Dorothy Gerringer, Larry Oliver and myself. And that was a very crucial time, because 1972 was a watershed year when everything went wrong in the country. The amounts of monies for innovation, the amounts of monies for education, and all those things started drying up. The real visionary things went on in the late-60s, early-70s, and from then on it was never never the same, in the sense that the international financial problems and many other things circumvented the ability to do things. About that time, it was decided that we should do some major demonstrations, because we felt we were about ready to do something significant, and that if we didn't do something significant we would probably not have the financial resources to do it again. So, we focused on the PLATO Project, Don Bitzer's activities, and since we didn't want to go with just one, the MITRE TICCIT Project was also fostered. These were two dynamically different diametrically opposed types of deals. One was a large, centralized system that would send messages through networks. Initially, it was viewed as a . . . to use satellites or cable, and telephone companies wouldn't cooperate so and many other things. The PLATO terminal was developed, which was extremely good on distributed types of communications because of the construction and design, and then the ticket system was a mini-computer, which eventually became a microcomputer, and to use television, as well. So the idea was to make small, autonomous units and/or one large network. At that time, we were supporting Seymour Papert to develop LOGO. Earlier, the Education Directorate had supported Tom Kurtz and

ASPRAY: BASIC work?

MOLNAR: BASIC. So there were many things going on at that time, very notable things. The Foundation was instrumental in the Curriculum 68 and the Curriculum 78 activities. At that time, there were I don't know 25, 26 different names that computer science went under, and the number of curricula were just as many as there were institutions. And so therefore, it was really a stroke of genius the Curriculum 68 committee they didn't tell people what to do or how to do it. What they did was to survey what people were doing and they grouped them into logical areas, and they said if you were going to call yourself "Computer Science Department" that you really ought to have

something in each of those areas and, if you lacked for names, they gave course descriptions. And what they essentially did was give the field the freedom to decide what they could do best and how they could do it, and to converge onto a standard curriculum. And then, in '78 Curriculum 78 IEEE and ACM worked closely together to be sure that they would coordinate their activities and, while there was some divergence in the curriculum, for the most part it was very well coordinated, to be sure that they were compatibilities. Also about that time 1969, I think it was no, June, 1970 we started the Computer Conference on Undergraduate Curricula. I have the whole series here, if you're interested. Basically, the idea the first conference was at Iowa and Jerry Weeg [?] was responsible for organizing that conference was to take a look at what we could *actually* do. In other words, the ticket to the conference was that you actually had to be using computers for some real purpose in the classroom, not some grandiose plan, or some long-term goals or objectives, but to actually have something going on. And, so therefore, these people came together and exchanged ideas about what was going on.

ASPRAY: How long did this last?

MOLNAR: The National Education Computing Conference was the spin-off of that. NSF supported it for a number of years. In 1979, in lieu of the 10th Computer Conference on Undergraduate Curricula, the intent was to create a consortium for computer-related activities and to support a joint effort called the National Education Computing Conference. Since then, I guess it's been what, 20 years now? I can give you this. This is a speech that I made. At that time, we wanted to get the people together who were organizers and movers in those activities, and to give a brief historical perspective. What I've tried to do was to organize some of the early thoughts of the history of education and to single out people who've made major contributions in the field.

ASPRAY: So this document has some of the things you've already been telling me about?

MOLNAR: Yes. More detail, more explicit.

ASPRAY: I'd be *very* interested in having a copy of that.

MOLNAR: It goes back to the first computers and the first computers in education, which we date around 1958, '59. So, basically educational use of the computer, per se, for educational activity is about 30 years old 30 plus.

It's not that people didn't use them for educational purposes, but the devoted purpose for education dates back to IBM in 1958 and their arithmetic computer in system development, 1959, and their computer-aided teaching project called CLASS, and finally, PLATO PLATO III, which was Don Bitzer's venture into doing a whole system dedicated to teaching. So basically, the first systems that begin for educational uses were, essentially, PLATO, plus or minus a few years. That's not that people didn't do demonstrations or experiments, or use the machines for administrative purposes and also do activities, but for the most part, the dedicated systems began in about 1930 I'm sorry 1960, '59-'60. Then the other thing that we did at that time was we were concerned that we had created about 25 educational regional centers. The idea was to take computing out and get it to as many people as possible, including minority institutions. In fact, horribly, I think some of those mini-computers that were given to some of those minority institutions are still running and still being used. Bennett College, Morgan, a number of minority institutions also became involved in using mini-computers and mainframes for regional activities. But we were concerned that some of them were extremely successful and some were not extremely successful, and so we wanted to know *why* that was so and, more importantly, whether we could build upon that base. So, Jerry Weeg at Iowa, and Tom Kurtz at Dartmouth, Parker at North Carolina oh, what's his name? at Texas? It starts with a "W." And at Oregon State, and formed a consortium called CONDUIT, and the intent of this was to take educational materials and to force them among the various networks. Most networks would be happy to send you materials, but nobody would accept materials, because they didn't know whether to program them in BASIC or FORTRAN or just the lack of documentation to make them work. About that time there was a study on uses of correlation. I think they went to about 30 institutions and gave them a common formula and they got 30 different answers. Wide variations in outcomes. So the concern was how do we get networks to cooperate? How do we get networks to exchange materials and, more importantly, how do we get them into the classrooms? What did you have to do to get them into the classroom? So, what CONDUIT did was to take about seven areas of science and exchange them among each other. If they came in in one language, they were translated into another language, and to certify that, in fact, things

worked. While they initially wanted to do effectiveness of educational materials, we soon came to the brutal conclusion that certification was about *all* you could offer, mainly because the programming had errors in it, the programming was inefficient, the substantive materials were often in error, and only someone with programming and experience in one of the disciplines could detect those errors if *he* could detect them at all. And very few people had thought about how one would introduce it into the classroom and what they would use it for. And so the centers exchanged, they created common documentation to accept and exchange materials; everything that was written in FORTRAN was also written in BASIC, and whatever special equipment that was required to run them. And then they were moved into the teachers' classrooms, and they were tried out, and then we did some research to find out why people accepted it, what they would do to adopt it, and we found out that merely mailing things to people didn't work. Sending the materials didn't help, documentation wasn't too good, and that if you had an expert in the field who ran a workshop, that that was probably the most cost-effective way of distributing information. And, more importantly, we found that it was very interesting trying to compare all of the networks to see if there was some pattern as to why they succeeded or didn't succeed. We basically came to the conclusion, the informal conclusion, after the study was that some places had a critical mass of people who were involved in computing, and in those places *everything* worked, documentation or not. And other places with equal reputations, equipment and people that didn't have a critical mass, very little worked in terms of transfer. And, more importantly, that people didn't want networks like the National Research and Education Network. But, at that time, people wanted small, stand-alone mini-computers, because it was *theirs*. Students couldn't run up exorbitant bills. If it was down, *you* brought it down, not somebody else on the network. And so therefore, in spite of all the attractive incentives to join networks, the people still wanted minis. Let's see, what else was going on?

ASPRAY: What was the date for CONDUIT?

MOLNAR: I'd have to look it up.

ASPRAY: Even *approximately* is just fine.

MOLNAR: Early '70s. About '75, one of the forerunners we set up a project with the MITRE Corporation to wire homes in Reston, a satellite community outside Washington, so that you could have two-way television and computing into the home, and the idea was that we were now in a position to be able to network cable, so that we could have two-way, interactive television *and* computing. And, basically what they did was the computing was a drop-line via telephone, and it was two-way cable for television. And we needed materials so we set up Suppes' drill and practice, and they did computing in classes and in the home, as well as throughout the network. It was later picked up in Buffalo, New York, for a project for the handicapped. That is, the cable company up there ran some channels for teachers to work with handicapped kids who couldn't get to school, and for them to be able to look in on the class and the teacher could look in on them. I'll give you this I don't know if you want to repeat it or anything

ASPRAY: Maybe I should just ask you some questions, then. Why was the move of education out of OCA into an education division? Why did that occur?

MOLNAR: Let me answer that indirectly in another way. We had two Deputy Directors at the Directorate. I had personal conversations with them after they left the Foundation. And basically they said we were an awkward group for them because we were proposing things that were unique and hard to understand and difficult to do. And they came, unsolicited, and said that this was really a great program, fantastic. And we said, "Well why did you beat us down and struggle on every project that we proposed all along the way?" And the answer was, "Well, we didn't understand it, and we were not about to go before Congress and present something we didn't understand." And basically that was the problem with regard to education. That is, education has a from my experience, having run a number of technology program from about '66 on, education is a people business . . . resources go to people in the 50 states. Technology involves equipment and that steals from people, and that no technology budget would ever exceed ten percent of the education program. Where in OCA, the interest was how far could we push the technology to do compelling and interesting things. There were no constraints about how many fellowships, how many teacher institutes one had to have. And so by the Education Directorate was having troubles with MACOS and other activities, and the Foundation was never comfortable with education as an activity. Several Directors, including Stever, had surveyed the Board to do away with education, and it wasn't until 1983 when they actually *did* do away

with it. Then the government decided the administration decided that there was no need for science education in the United States, so it was dis-established. At that time, I was the only Program Officer left. I had 500 grants some interesting ones and we were supporting a University of Virginia network on CAD, "C-A-D," network. We were supporting the audio-visual engineering programs to create audio-visual materials for computer science and engineering, which ultimately led into Lionel Baldwin's National Technology University. But, at that time, we had no money, and Dorothy Gerringer and I sat down and found that the Foundation could get gifts. There's a provision in the Foundation that we could accept gifts, so we went out and solicited vendors, and five vendors gave us equipment systems which we used to make awards; for instance, IBM, Apple, Atari I can't remember all the others now. And, at that time, we had no money but DARPA was very interested in the University of Southern California program on fast fabrication. At the urging of DARPA, NSF set up a graduate and undergraduate program to permit free access to the fast fabrication facility. John Lehmann, Bernie Charrin and I were the screening committee for access to that system. At that time there were no courses available for engineering design, and the only requirement we placed on them was that once they had had the unit fabricated they would have to test it and put the results back into the network. And that project advanced engineering education by at least a decade. And, at that time, people were concerned that *maybe* graduate students might be able to find something of use in that program; certainly undergraduates would never be able to do anything of value. And now there are cases where patents and awards are coming out of the undergraduate programs. While that was about '83, I guess most major universities now have access to such facilities. But, the point being that what we did was to dis-aggregate manufacturing from design and to submit things through a network, and to permit teachers to design all sorts of courses that would take advantage of that facility. And it was extremely profitable for a very small investment. At that time I had 500 awards in all fields of science and all levels of education. I had the program for giving out awards on the microcomputers. I was the Chairman of that group that compared the guidelines for the fast fabrication unit and, at that time, since we did away with all of the education programs the White House was a little nervous and called over and said could we make awards to teachers in the 50 states toward math and science *in two weeks*. And we said, yes, you *could* do it in two weeks, but you might be disappointed in the outcome, and so therefore I undertook to set up a mechanism and a planning unit that would give presidential awards and we ran the first conference at the White House. And Ronald Reagan came to make a speech, and wowed 'em all. He was a marvelous speaker; the teachers were falling all over

themselves just to touch him.

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MOLNAR: And also in that time period, that first year, I guess I made 20, 24 speeches from Alaska to Florida. I had no secretary, no programs budget, and no travel budget, so it was a very productive year, and I guess it reinforces the observation that the optimum committee size is .7 people. But then we were reconstituted. A commission was formed and they made recommendations for math and science *and* technology, so there's a commission report that focused on technology, and from that began this program that I'm running now, which is the Applications of Advanced Technology. We tried to learn from the previous activities and to say that our concern is not on what was out in schools, but what was going to be out in schools five to ten years hence. The Foundation, interestingly enough, until 1975 never had a research program in education, and has always resisted educational research. Therefore, in about '75 we had a small research program science education and a development program in science education. We could do development but not research, and research but not development. So, in setting up this program, we focused on doing *both* research and development at all levels of education. We concerned about important things that were going to be important five to ten years from now, because those systems actually exist and we wanted to work with those prototypes so we could lay the foundation for decision making at that time. And, more and more, what has happened is the threshold of complexity in science and the dependency upon technology-based instrumentation became crucial and critical, so we were concerned about new subject matter chaos, fractals, animations, parallel processors, and so therefore we started focusing on trying to take a look at cognitive science, artificial intelligence, and advanced technologies in the various domains, beginning at the earliest grades to the post-graduate level.

ASPRAY: Around 1970, what was the attitude within OCA towards CAI?

MOLNAR: Nobody liked the term "CAI." Everybody felt it was a misnomer, but it was so popularly wide-spread by the publicity in newspapers that there was no way of converting it into anything else. We tried to talk about

computer-based education   computer-managed education came along. But the idea was to look for words that would be useful, but you could not change the description that had wide-spread use. Early on, when we were working with Pat Suppes and when I was at the Office of Education, Suppes was, and still *is*, a marvelous man. He just got the Medal of Science this year for his educational activities. One of the few educators   and certainly the only one that I know of   that is involved in uses of computing for educational purposes. But what Suppes felt at that time was that the important thing with regard to education was to do something immediately that would draw attention to the needs of education and to the utility of computing. And so his concern was not to design the *best* system, but to design the system that would be most readily used, immediately. Probably no other name is more closely connected with CAI than Suppes. For years they were synonymous. He was the Director of the Institute for Mathematical Studies and Social Sciences at Stanford. Ken Harold, the Nobel laureate, and Suppes created the laboratory, later joined by Dick Atkinson, who eventually became the Director of the Foundation and then went on to San Diego. Between '59 and '61, Suppes began his experiments on learning mathematics, and this eventually led to his interest in teaching math. In '63, Suppes developed his computer-based laboratory; Atkinson focused on reading, Suppes focused on mathematics and practiced it. A very interesting thing about mathematics   you go around the country today and other places, you find that it's one of the few things that shows educational benefits. At that time, Suppes was able to go into very poorly -run educational environments and produce results immediately. We're never able to do that with reading. In fact, an elaborate study was set up in the State of California, an extremely well-controlled study, to look at reading, arithmetic and one other area, and they had combinations of these; they had them singly, but one of the best controlled studies that was ever run. It was run for two or three years so they could look at long-term effects and short-term effects. The drill and practice reading did work. Improved performance very significantly. Very cost-effective   reading did not. In fact, I think there was a deterioration in performance in reading, by using Atkinson's reading activity. But the basic point is that, for certain areas, drill and practice is important. Since then, we've now had the cognitive revolution where formerly education was thought of teaching people taxonomies and definitions and algorithms, and then the cognitive revolution came along and said, "Well, look. We should look beyond learning, and we should look at thinking   how people solve problems, how to organize their thoughts." And that changed, dramatically, the focus of attention. But it didn't take or detract from the CAI effort. Pilots, surgeons all need drill and practice on what they're doing. The theory is that automaticity, that is,

the brain, is overloaded by information and activities, and that if you automate some of these activities you don't think about them, so therefore you don't use brain capacity to think, and so therefore you're able to take on more things. Early in the game, Suppes, in some of the better-controlled experiments at that time, found some of the control groups were doing as well as the CAI groups, which was astonishing. . . . and what he found was teachers that said, "We aren't gonna let those computers beat us, kids. We're gonna work like heck day and night, and we're gonna do as much as we can to beat them." And they did as well. And that became a component of the sell force, that is, the idea was that, yes, teachers and students *could* do well, but they had to include special pressure, and in those cases where you didn't have teachers and you didn't have that motivation that the technology did do it well.

Bitzer's approach was totally different. Bitzer felt that everybody knew what to teach, and therefore what you have to do is provide them resources to teach. And so any professor and to some extent he was correct, in the sense that some people do well at teaching certain aspects and they wouldn't *dream* of substituting a computer to do that. Other things they didn't do well in, they were happy to relegate. And I remember going up to Illinois during student demonstrations and riots, and visiting the computer facility at 10 o'clock at night. Students were out demonstrating, tearing up the campus, and there they were hundreds of students working on the PLATO system, doing their homework, and that was interesting, to say the least.

ASPRAY: Can you tell me something about the popular impression of CAI at about 1970? Was there a sense that it was going to be a great saving grace, a powerful tool, that would help with mass education. What *was* the general feeling outside of the agency?

MOLNAR: I think the people in the Foundation and the people in the field had great optimism about what could be accomplished, but they were all realists. They knew what the problems were about technologies. They the difficulties using technologies. They knew the limitations of the materials that were out there. Add, to this day, a great skepticism. I have a file of people well, magazines such as *Science* who, you would think, would be objective come in ask you, "What's going on? What are the outstanding things?" And then they will always ask you, "Can you give me some names of people who don't believe technology works?" And I have a whole list of

names up there that I have to give to the newspapers of people who are nay-sayers who may work with technology . . . for any purpose. And, in fact, if you look back historically, most of the government activities the Department of Education and the National Science Foundation have been most of the programs were aimed to *curtail* the development of technology. In other words, they did not want to see a wide-spread use of technology. The importance of technology in education is really a grass-roots revolution. It began with parents who worked in the industries that were involved with technologies who brought these tools to the students. The students showed them to the teachers. The Nation At Risk Report was the first time that technology was accepted as a reasonable thing to teach in the curriculum or to use in the curriculum. We distinguished between technology as a medium, technology as a tool, and technology as a study area, the object of study. So we supported a wide range of projects to do many things, and CAI, to this day, in its place, is useful. But what we found with CAI was that, while kids learned dramatically better and dramatically faster than the traditional methods, they also learned the same mistakes that you taught to them in the traditional methods.

ASPRAY: Excuse me if I belabor this point slightly, but I have what I regard as an unreliable source and who has told me the following, and I'd like to get your opinion on this. That there was a certain amount of pressure placed by both the White House during the Johnson administration and the Nixon administration on value of CAI, either as a way of educating the masses or of cutting the cost for education Johnson to Nixon but that there was in the Foundation a certain skepticism about these hyped-up values of CAI, and especially among the scientific advisory committees for the Foundation.

MOLNAR: It was far more chaotic than that. We prepared some testimony for congressional committees at that time that were interested in looking at alternative ways of doing education. You have to begin back with the Elementary-Secondary Education Act. After the war and Sputnik, there was a great concern that our education was dated it was obsolete. Followed the regular 30-year cycles of concern about education. At that time, a very innovative act was created that committed schools to do many things that they had dreamt of, but never had the resources to do. There was a tremendous concern about the role of education. In the Department of Education, I remember a congressman telling us in the committee that, "You have done nothing. You've done a splendid job." In other

words, the concern was to keep the federal government out of education *totally*. Anything that smacked of federal leadership or intervention was looked upon very negatively. So therefore, the Elementary Education Act permitted people to do research on interesting things in a distributive way all over the country. So, a thousand flowers bloomed. Nobody thought of education at that time. I'm pretty sure I coined the phrase "the knowledge networks" that Johnson used in a speech. Congress funded the act, provided no money for it, and after two years had an evaluation. Of course, nothing was accomplished, so they did away with it. The concern was not for education, although later in Johnson's years, the National Defense Education Act, the Elementary-Secondary Act below visibility, there were these computer things going on. There was no coordinated direction. There was no intent to use technology. If anything, the intent was to *restrict* the use of technology by many means. In other words, we provided training, but no equipment. We provide the equipment, but no software. We provided software, but no materials. And so therefore we spent the estimate I did was something like a half a billion dollars on technology in education, but they were so uncoordinated that you either had to be a liar, a thief, or corrupt in order to put all of these things together to do a program that would involve technology in any significant way. As I said, the science part of the Foundation never really accepted education, was always suspicious of education. Many attempted to try and do away with it. Now, along comes a group that was fine in the Office of Computing Activities but now it became part of the education group, and so therefore there was great skepticism about the uses of technology and the Board was against it. The Board didn't want to support these types of activities. Don Bitzer was invited to the Foundation to make a presentation. The Board knew nothing about technology for educational purposes, and he did a pilot a pre-test when he came here and nothing worked. They corrected everything and they put on a demonstration for the Board. And the Board was extremely skeptical. But people like Stan Smith from Illinois, who was an outstanding chemist, a marvelous teacher, would say, "Alright, tell me what you want to show in chemistry." Bitzer would type in his PLATO symbols and it would come up on the screen, and it would come up on the screen, and it's all problems in chemistry and chemical simulations, and the chemists on the Board were just astonished. They didn't believe this could be done. With that demonstration, the Board supported the major test of computer-assisted instruction, Bitzer's project at Illinois, and the MITRE project. Went to Congress, put on similar demonstrations, and Congress was wowed. They permitted us to do those major demonstrations, but didn't provide the money. Therefore, we had to take them out of the programs to support them. So the one showdown [was

education.] [That is] where the Board was naive, in my opinion, unfamiliar major university presidents and business and industry people who were concerned about basic science, and basic science's role in society, but were less concerned about small science and almost indifferent about education. And in Stever's time, the Board was shy by one vote from doing away with education and when Branscom came on they did away with it. There's a whole story behind that that's probably not worth relating. It's mostly political. But, yes, there was skepticism. There was skepticism in the program. Now, the other part that you have to concern yourself with is going back to federal intervention. At that time, the concern was not to develop something that would go out and do great things and get people to use it; that was intervention. We had to take a more subtle role and to create alternative systems. The Foundation's curricular programs there's something like 23 programs, SMSG, all of the programs were alternatives. In other words, the assumption is that schools know what they want, publishers publish what they want, and therefore the role of the federal government was to create alternative systems for the gifted and talented, and for the disadvantaged, and for people that wanted to do things differently, and to provide these alternatives for them to do whatever they want to do. And so therefore, it was important to create a wide array of programs. Computer-managed instruction we started computer literacy in '72, we coined that phrase. It's sort of ironic. Nobody knows what computer literacy is. Nobody can define it. And the reason we selected computer literacy was because nobody could define it, and nobody knew what it was, and that it was a broad enough term that you could get all of these programs together under one roof. And so therefore we initiated some national conferences and we did a number of things. We back in 1975, we were concerned about the future again. And, in fact, we had people like J.C.R. Licklider and John Seely Brown Licklider from M.I.T., Brown from Xerox and others to try and look at what the potential in problems were for 10 years hence. We had a national conference in '75 where we set up a system where we called all the experts we could find related to technology, education, the whole thing. So, we would ask, "Who are the most outstanding people in the country that know something about large memories? Who are the people that know something about . . ." We had all those people in the conference; it was a marvelous conference. They had to write a ten-page paper. Out of that conference came probably Licklider stimulated it an optical disk that would be very useful for computing and especially for education. We then initiated a conference where we went and got the Dutch, the French and a bunch of university people, and we said we went to the vendors Thompson, France and let me see, what's the Dutch company, I've forgotten what its name is. What would it take to bring these video

disks out into the community for education? And they said well, they didn't see any educational use, but if we could promise them a million sales a year, they'd be happy to bring it out. And so we went a step further, and we said, "Well look, we have things, like small computers, now that are coming along and we have this optical disk. Could we take the best of both and create a system?" And Al Bork at Irvine chaired that conference, and we designed an interactive computing system. And then we set up two proof of concept tests. Vic Bunderson at Brigham Young created an interactive video for DNA. And another project at Utah the University of Utah was doing physics and engineering using interactive video disks. So therefore they had to develop authoring languages. And so we were really quite ahead of the field in doing those sorts of things. But the long and short of it, yes, there was lots of skepticism about education in general, technology in education in specific, and we were constantly engaged with questions and challenges and limitations in budgets. And when Dick Atkinson came on as the Deputy Director it didn't help at all, it made things worse. The program essentially disappeared. But there was a stout-hearted community out there that had done some outstanding things, and that persisted. And so, again, it was essentially grass-roots.

ASPRAY: In your estimation, were the TICCIT and PLATO projects successful demonstrations?

MOLNAR: Yes, I think they were. That is, it was at a time when budgets were contracting and when there was a waning interest in doing anything that would be extensive in education, and they brought lots of attention to it. The PLATO system the intent of those projects from the Foundation's point of view was to do a demonstration that would be very convincing, and to do an evaluation of those that would convince the educational community, *and* the business community, to take over those projects and do them. And, in fact, that goal was accomplished. Control Data took over PLATO and spent over a billion dollars in very creative activities that were still way ahead of their time. And the MITRE Corporation took over the TICCIT Project. So, the goals were accomplished. Probably more people have used the PLATO world-wide than any other educational system. Saudi Arabia, the Department of Defense, the Internal Revenue networks around the country, for air traffic controllers, the military, have all used PLATO, and it was very effective in the military where you could cost peoples' time if you were a soldier, you got a salary if you went to training classes, you absorbed certain times and were able to cost out that, in fact, it was a

very cost-effective system for the military. The systems were predicated on getting computing to *large* numbers of groups, and the plasma display probably eventually will out and become the wall-to-wall displays that we use. But Bitzer was ingenious. I remember when he came to me with four cells full plasma cells and said he wanted to make a display out of this plug it in and it would light up, and . . . that light. He said you could imagine a screen and I couldn't imagine a screen but he could, and he developed a really phenomenal system. Now, the problem was it lacked pedagogy, it lacked computer power. The telephone companies would not permit him to run what he was after was educational discounts, because what he wanted to do was distribute these from the central system and distribute them to the terminals, the intelligent terminals, and to present them to students at very low cost. And the telephone company said, Well, yes, but those that's not television." And he said, "Well, can't you think of them as funny pictures?" and they said, "No, we *can't* think of them as funny pictures." The most cost-effective thing that he *could* do was to use the telephone lines at an educational discount or cable, so therefore he had to develop other ways of driving down the cost.

The other thing that we did on the current program that might be of interest is that we felt that cost-effectiveness was not a very useful term. The paradigms for evaluation were not very useful in the uses of technology. But everybody asked, "Does it *really* work?" And so, we wanted to be able to answer that question, and so we gave John Kulik an award, University of Michigan, to look at all the cost-effectiveness studies went through 3,000 studies and culled the best and most effective elementary, secondary, higher adult levels. In fact, using brute force technology very little pedagogy he was able to demonstrate that the computers *did* improve performance 10-20 percentile points, could reduce time on task by one-third, and kids liked working with it. This was elementary, secondary and adult education. Similar results came out of the military non-commercial sectors. What we were saying for our new programs is that we wanted to use that as a base, and we wanted to do things that were orders of magnitude better than that. Therefore, Kulik also went further to compare effectiveness of technology with other forms of pedagogy, and did meta-analyses on other forms of pedagogy. It turns out pretty well. There's one cost-effectiveness study out of the University of Chicago that says computer-assisted instruction is three times more cost effective than tutoring, which is the ideal in education about a one sigma difference, less than a one sigma difference. What we're aiming for are three sigma differences in our program. Suppes, using intelligent systems and, in fact, the real thrust

after '83 came from the Science & Technology Committee at the White House. They brought in people they asked the Academy to do a study of artificial intelligence and computing. The Academy wasn't interested, and so they directed them to do it, and their reaction was that "we have to see we have to try this out, to see how far we can go." So we picked that up and included AI techniques and did intelligent tutoring in calculus, algebra, geometry, pre-algebra, algorithm problem solving at all levels of mathematics, with the attempt to try and show that we can achieve a three sigma difference. We went through several iterations and wanted to go beyond just one application to see if we could generalize to *a lot* of applications. Suppes just reported results on calculus with seventh and eighth graders and did a pilot with our concern is with kids in rural locations that don't have access to teachers. I think it was something roughly about, at the undergraduate level, something like 970,000 kids pre-calculus; only about 140,000 graduated with a 'D' or better, and most of those people never take calculus again. Most countries throughout the world teach calculus at the high school level; about 5, 6, 7 percent of our kids take calculus. Most of them have to re-take it. Therefore, remediating calculus is not an answer. In other words, you have to begin back at the early stages to find out and we did a lot of studies on expert/novice evaluations to find out how experts solve problems. But, Suppes' initial activities with 13 kids in Grades 7 & 8, taking the interactive calculus course, and then taking the Advanced Placement Test, found that six of them got the highest score on the Advanced Placement Test, six got the next highest, and one got the '3,' which is passing. We've also done things with geometry, and that's probably our best hope of getting the three sigma difference. In other words, three times better than what your best tutoring can do with a human. John Anderson at Carnegie Mellon developed a theory of learning and cognition, and we're now testing it in algebra and in geometry. We've also focused on creating intelligent tools, and trying to anticipate what new technology-based curricula are coming down the line. But, the support for technology by professionals, decision makers, has not been strong. Beginning in '82 was the Nation at Risk. They argued that computers should be as important as reading, writing and arithmetic. So therefore, the antagonism between the educational community, the people who were not familiar with technology shifted, and therefore the use of computers in schools became an essential requirement. Since then, there've been about 20 or so national commissions and reports that have made computing, technology, programming by people who don't really understand it as a *basic* in education. So, now the arguments have shifted from trying to create a justification for *why* technology should be used in schools to, now, the nay-sayers trying to justify why it *should not*. And we've had some dramatic results, I

think, in terms of new uses of technology and science, and certainly a lot of advances in the quality of the systems. In the initial IBM system, and the former Director was always embarrassed because he had some responsibility for that in IBM it was a failure and in that IBM system, you would add '2' and '2' and then you'd have to wait about 30 to 40 seconds for the answer to come back, "4," and then the kids would fall asleep, and would be hardly able to go on to the next frame before they got bored silly. So, you had places like Stanford, where drill and practice was limited to 10 minutes, because that's what the kids' attention span was when they would practice, to places like M.I.T. with Seymour Papert where kids would stay hours and hours running the turtle and he had worms, and spiders. These were elementary kids from inner-city schools, and Papert, I think, has created some *extremely* innovative ideas about uses of technology. What we essentially tried to do, initially, was to take technology and substitute it for the teacher, the things that teachers did, never asking whether you might want to teach something different now that you have technology, or that you might want to use different means of instruction, or you might want to create new educational strategies. All of that's been, I think, more in the last 10 years, and those changes have been very dramatic in the educational system.

ASPRAY: Let me ask you a rather different question. As I told you, we were trying to pull together biographies of various people who have worked on the staff. One person who we've been having trouble finding material about is Offenkamp. What can you tell me about Offenkamp?

MOLNAR: Well, if you haven't looked in his if you haven't gone to the Help Unit and looked at his pictures of Paris, I think you've missed a great treat. Don was a marvelous photographer. You ought to go to the Help Unit downstairs on the fourth floor, and then just look at the walls. After the computing activities, Don went into the Physics Directorate, and then eventually into the Russian-U.S. program. Don learned Russian, and went to the Soviet Union, and worked closely with the Soviets on the Russian-U.S. programs. Don was a computer director. I'm trying to think now of the university before he came to the Foundation. He was extremely instrumental in those initial awards that he made putting major mainframes into universities. A very, very inventive and ingenious person. I don't know. Glen Ingram could probably tell you more about him. Arthur Melmed, also.

ASPRAY: I know where Ingram is. Where's Melmed?

MOLNAR: Melmed is in town. He's he's affiliated with New York University now, but he's essentially retired and he's doing some projects for us on the future of fiber optics into the home, and what it'll take to scale up computer activities to affect millions of people. Our major concern, these days, is scaling up and that types of activities. This is not new. We've done this before with technologies.

But, I really can't help you *too* much about the details and Don. He left the program and went to Physics, and then, as I say, went to the international types of activities; learned Russian fluently.

ASPRAY: Do you know what his education was in?

MOLNAR: Physics, I believe. Most of the people, of course, were never trained in computing. Probably one of the most significant documents that we turned out in the early conferences was a conference in physics back in around 1970, and the paper's in that collection this conference was held at Illinois Institute of Technology and Peter Lykos was involved. We had a lot of people that came in. We had rotators that came in to our program, that were involved in computing still *are* involved in computing. I guess I can locate these things.

END OF INTERVIEW